



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
-----------------	-------------	----------------------	---------------------	------------------

10/052,306

01/18/2002

Yumiko Kawano

2285/51302

8383

23911

7590

05/19/2004

CROWELL & MORING LLP
INTELLECTUAL PROPERTY GROUP
P.O. BOX 14300
WASHINGTON, DC 20044-4300

EXAMINER

KIELIN, ERIK J

ART UNIT

PAPER NUMBER

2813

DATE MAILED: 05/19/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.		Applicant(s)	
	10/052,306		KAWANO ET AL.	
	Examiner		Art Unit	
	Erik Kielin		2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
 - If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
 - If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
 - Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 23 March 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-16, 26-34 and 38-41 is/are pending in the application.
- 4a) Of the above claim(s) 5-11, 13, 16 and 32-34 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-4, 12, 14, 15, 26-31 and 38-41 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

This action responds to the Amendment filed 23 March 2004.

Claim Status

Claims canceled: 17-25, 35-37.

Claims newly added: 38-41.

Claims pending: 1-16, 26-34, 38-41.

Claims withdrawn from consideration: 5-11, 13, 16, 32-34.

Claims being examined: 1-4, 12, 14, 15, 26-31, 38-41.

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 1, 14, 27, 39 and 12, 15, 30, 40 are rejected under 35 U.S.C. 102(b) as being anticipated by **Wolf**, Silicon Processing for the VLSI Era, Vol. 2-Process Integration, Lattice Press: Sunset Beach CA, 1990, pp. 245-252.

Regarding claim 1, **Wolf** discloses a method of manufacturing a semiconductor device comprising:

Art Unit: 2813

a preparation process step of supplying and absorbing a substance (specifically Ar and WF_6) for restricting adhesion of a material (specifically H_2 and/or WF_6) for forming a tungsten film or a tungsten compound film and for restricting formation of nuclei for growing the tungsten film or the tungsten compound film onto a surface of a process target substrate; and

forming the tungsten film or the tungsten compound film on said substrate by supplying said material for forming of said tungsten film (specifically H_2 and WF_6) or said tungsten compound film to the surface of said substrate after said preparation process while restricting adhesion of said material to the substrate by said substance adsorbed on the surface.

Regarding claim 12, **Wolf** discloses a method of manufacturing a semiconductor device comprising:

a preparation process step of supplying and adhering a halogen containing substance (specifically Ar and WF_6) onto a surface of a substrate, the halogen containing substance restricting adhesion of a material (specifically H_2 and/or WF_6) for forming a tungsten film or a tungsten compound film and restricting formation of nuclei for growing a tungsten film or a tungsten compound film; and

forming a tungsten film or a tungsten compound film whose surface has bumps on said substrate by supplying a material of said tungsten film (specifically H_2 and WF_6) or said tungsten compound film onto the surface of said substrate after said preparation process step.

(See Wolf, p. 246, last paragraph and Figs. 4-40 and 4-42. More particularly, compare the last paragraph on p. 246 with Applicant's Fig. 2 which shows that Ar and WF_6 is the preparation step gas while WF_6 is also the gas to form the WN_x film.)

It is seen to be inherent that the treatment with Ar and WF_6 restricts the adhesion of a material to the substrate. Reasoning follows: because WF_6 has adsorbed to the surface of the substrate, as indicated in **Wolf**, and as admitted by Applicant in the instant specification (instant specification at least Fig. 2 and the claims as presently written) the adsorbed WF_6 prevents restricts the adhesion to the substrate by occupying space on the substrate and providing steric hindrance. In other words, if the adsorbed WF_6 and/or its by-products such as tungsten and fluorine are occupying space on the substrate it necessarily restricts adhesion of additional WF_6 or H_2 to the surface of the substrate at that space occupied by the adsorbed tungsten and fluorine. Accordingly, the claims as presently written, read on the prior art of **Wolf**.

See *In re Swinhart*, 169 USPQ 226,229 (CCPA 1971) (where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that subject matter shown to be in the prior art does not possess the characteristics relied on) and *In re Fitzgerald*, 205 USPQ 594 (CCPA 1980) (the burden of proof can be shifted to the applicant to show that subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 USC 102 or obviousness under 35 USC 103).

Additionally, the instant specification provides evidence that WF_6 restricts the adhesion of NH_3 and WF_6 . See instant specification, Fig. 2, and pp. 11, p. 12, lines 20-27, which states,

"By supplying WF_6 onto the surface of a semiconductor wafer W before a tungsten nitride film is formed, formation of a tungsten nitride film can be controlled. That is, the density of nuclei (growth nuclei) which are formed during earliest stages of film formation can be reduced. It can be considered that this is because WF_6 is deposited on the surface of the semiconductor wafer W in the preparation process [as shown

in Fig. 2], and the deposited WF_6 restricts (or prevents) formation of nuclei. That is, **WF_6 prevents NH_3 which is the other material gas for forming a tungsten nitride film from being adhered onto the semiconductor wafer W.** (Emphasis added.)

While the above excerpt from the instant specification provides evidence by Applicant's admission that NH_3 adhesion is prevented, given the original and present claim language, the same excerpt must also provide implicit evidence that WF_6 treatment prevents adhesion of WF_6 . **Otherwise the instant claims are not enabled.** Because NH_3 is not used to deposit a "tungsten film" as presently claimed (tungsten nitride results if NH_3 is used), then NH_3 is not being restricted. Then it must be some other gas involved in the "growing the tungsten film" whose adhesion must be restricted according to the claim language. The only "material" used in "growing the tungsten film" is WF_6 . **Otherwise the claims are not enabled.** Accordingly, Applicant admits that WF_6 treatment prevents adhesion of WF_6 .

Regarding claims 14 and 15, the adhesion of said material for forming the tungsten film or the tungsten compound film is controlled by controlling the time during which the preparation process is performed. See **Wolf**, last paragraph of p. 246 which indicates that the surface of the substrate is treated with WF_6 until which time the silicon substrate stops reducing the WF_6 . This is a predetermined time.

Regarding claims 27 and 30, **Wolf** discloses that the surface of said substrate that has predetermined roughness; and said film forming comprises forming on said substrate, a tungsten film or a tungsten compound film which has bumps that are rougher than the surface of said substrate (Figs. 4-40 and 4-42).

Art Unit: 2813

Regarding claims 39 and 40, the surface of the tungsten film or tungsten compound film is shown to have bumps (Figs. 4-40 and 4-42).

3. Claims 1-4, 26, 27, 38, 39 and 12, 29, 30, 40, 41 are rejected under 35 U.S.C. 102(e) as being anticipated by US 6,087,257 (**Park** et al.).

Regarding claims 1-4, 38 and 12, 41, **Park** discloses a method of manufacturing a semiconductor device comprising:

a preparation process step of supplying and absorbing a substance (specifically WF_6 , a halogen-containing substance --as further limited by claims 3 and 4) for restricting adhesion of a material (specifically at least NH_3 --as further limited by instant claims 38 and 41) for forming a tungsten nitride film by supplying WF_6 and NH_3 onto the surface of said substrate (See Fig. 4D) -- as further limited by instant claim 2-- and for restricting formation of nuclei for growing the tungsten film or the tungsten compound film onto a surface of a process target substrate; and

forming the tungsten film or the tungsten compound film (specifically WN_x) on said substrate by supplying said material (at least NH_3) for forming of said tungsten film (specifically H_2 , NH_3 , and WF_6) or said tungsten compound film to the surface of said substrate after said preparation process while restricting adhesion of said material to the substrate by said substance adsorbed on the surface (Figs. 4A-4D; col. 6, line 51 to col. 7, line 15).

The restriction of the adhesion of NH_3 by the halogen-containing WF_6 is seen to be inherent in **Park** by admission of Applicant in the instant specification See instant specification, Fig. 2, and pp. 11, p. 12, lines 20-27, which states,

"By supplying WF_6 onto the surface of a semiconductor wafer W before a tungsten nitride film is formed, formation of a tungsten nitride film can

be controlled. That is, the **density of nuclei (growth nuclei) which are formed during earliest stages of film formation can be reduced**. It can be considered that this is because **WF₆ is deposited on the surface of the semiconductor wafer W in the preparation process** [as shown in Fig. 2], and the deposited WF₆ restricts (or prevents) formation of nuclei. That is, **WF₆ prevents NH₃ which is the other material gas for forming a tungsten nitride film from being adhered onto the semiconductor wafer W.**" (Emphasis added.)

Additionally, **Park** implicitly teaches restriction of the adhesion of NH₃ by the halogen-containing WF₆ with reference to Figs. 4A-4D. At higher ratios of NH₃ to WF₆, the WF₆ is shown to be less effective in preventing nucleation (Fig. 4D). At lower ratios, on the other hand, deposition is nearly selective to the contact opening (Fig. 4B and 4C) because sufficient WF₆ can reach the surface around the contact opening to prevent NH₃ adsorption. (See MPEP 2112 regarding inherency.)

Note that there exists no required distinction in the preparation and deposition steps in the claims as presently written. In as much as **Park** shows selective deposition in the contact hole and not on the surface around the contact hole (**Park**, Fig. 4C; paragraph bridging cols. 6-7), it is clear that the surface of the substrate has undergone "preparation" since no nucleation and deposition of WN_x occurs on the area surrounding the contact hole.

Regarding claims 26 and 29, the substrate **100** has a planar surface.

Regarding claims 27 and 30, the surface of said substrate that has predetermined roughness; and said film forming comprises forming on said substrate, a tungsten film or a tungsten compound film which has bumps that are rougher than the surface of said substrate (Figs. 4C-4D).

Regarding claims 39 and 40, the surface of the tungsten film or tungsten compound film is shown to have bumps (Figs. 4-40 and 4-42).

4. Claims 1, 14, 26, 27, 39 and 12, 15, 29, 30, 40 are rejected under 35 U.S.C. 102(b) as being anticipated by US 5,633,201 (**Choi**).

Regarding claims 1 and 12, **Choi** discloses a method of manufacturing a semiconductor device comprising:

a preparation process step of supplying and absorbing a substance (BCl_3 , Cl_2 and HF) for restricting adhesion of a material for forming a tungsten film and for restricting formation of nuclei for growing the tungsten film onto a surface of a process target substrate; and

forming the tungsten film or the tungsten compound film on said substrate by supplying said material for forming of said tungsten film to the surface of said substrate after said preparation process while restricting adhesion of said material to the substrate by said substance adsorbed on the surface. (See Abstract; Figs. 2A-2D; paragraph bridging cols. 3-4.)

Regarding claims 14 and 15 the time that the preparation process is controlled for example at 30 seconds; therefore, the adhesion of said material for forming the tungsten film 8A is controlled at the substrate by this time (paragraph bridging cols. 3-4).

Regarding claims 26 and 29, the substrate 1 has a planar surface.

Regarding claims 27 and 30, the surface of said substrate that has predetermined roughness; and said film forming comprises forming on said substrate, a tungsten film or a tungsten compound film which has bumps that are rougher than the surface of said substrate (Figs. 2B-2D).

Regarding claims 39 and 40, the surface of the tungsten film or tungsten compound film is shown to have bumps (Figs. 2B-2D).

5. Claims 1, 14, 29, 39 and 12, 15, 31, 40 are rejected under 35 U.S.C. 102(b) as being anticipated by US 5,563,090 (Lee et al.).

Regarding claims 1 and 12, Lee discloses a method of manufacturing a semiconductor device comprising:

a preparation process step of supplying and absorbing a substance or a halogen-containing substance (specifically TiN; col. 4, lines 25-41 or alternatively WF₆ or WCl₆ col. 5, lines 19-33) for restricting adhesion of a material (specifically WF₆ or WCl₆) for forming a tungsten film 7 and for restricting formation of nuclei for growing the tungsten film onto a surface of a process target substrate; and

forming the tungsten film or the tungsten compound film on said substrate by supplying said material for forming of said tungsten film (specifically H₂ and WF₆) or said tungsten compound film to the surface of said substrate after said preparation process while restricting adhesion of said material to the substrate by said substance adsorbed on the surface.

(See also col. 4, lines 25-53; Figs. 1 and 2d.)

Further regarding claim 12, the halogen-containing substance (WF₆ or WCl₆) inherently restricts adhesion of a material used to form the tungsten film for reasons provided above under the rejection of the claims over the Wolf reference and are incorporated here.

Regarding claims 14, 15, 39, and 40 the preparation time for forming the TiN or for depositing the tungsten film 7 formation time controls the shape of the bumps to be at 50 to 150

Art Unit: 2813

nm and accordingly the adhesion of said material used for forming the tungsten film (as disclosed at col. 4, lines 34-53).

Regarding claims 28 and 31, the method of claims 1 and 12, respectively, further comprising

a step of forming a conductive film 9 which faces said metal film (tungsten) or said metal compound film via an insulation material 8, wherein said "method" forms capacitance (Fig. 2e).

6. Claims 1, 14, 26, 27, 39 and 12, 15, 29, 30, 40 are rejected under 35 U.S.C. 102(b) as being clearly anticipated by EP 0 349 695 (**Hirase**), the reference provided by Applicant in the IDS filed 4 October 2002.

Hirase discloses pretreating a planar silicon substrate having a predetermined surface roughness with a halogen-containing gas (N_2F_4 , ClF_3 , ClF_5 , F_2 , Cl_2 , and CF_4 ; Abstract) for a controlled period of time to control nucleation (i.e. prevent adhesion of a material used to form the tungsten or tungsten compound film) and therefore control the surface morphology (i.e. bumps) in the deposited tungsten or tungsten compound film (Figs. 1A-1C; cols. 1-4).

Response to Arguments

7. Applicant's arguments filed 23 March 2004 have been fully considered but they are not persuasive.

Applicant argues that Wolf fails to discuss the "preparation step" and that Wolf does not discuss how Anti-reflective and WF_6 restrict nuclei formation. First, Wolf discusses the preparation step in the last paragraph on p. 246, as pointed out in the previous and present Office

Art Unit: 2813

actions. Second, Wolf is not required to discuss an inherent feature of an invention. In this regard, note that as long as there is evidence of record establishing inherency, failure of those skilled in the art to contemporaneously recognize an inherent property, function or ingredient of a prior art reference does not preclude a finding of anticipation. *Atlas Powder Co. v. IRECO, Inc.*, 190 F.3d 1342, 1349, 51 USPQ2d 1943, 1948 (Fed. Cir. 1999) (Two prior art references disclosed blasting compositions containing water-in-oil emulsions with identical ingredients to those claimed, in overlapping ranges with the claimed composition. The only element of the claims arguably not present in the prior art compositions was "sufficient aeration . . . entrapped to enhance sensitivity to a substantial degree." The Federal Circuit found that the emulsions described in both references would inevitably and inherently have "sufficient aeration" to sensitize the compound in the claimed ranges based on the evidence of record (including test data and expert testimony). This finding of inherency was not defeated by the fact that one of the references taught away from air entrapment or purposeful aeration.). See also *In re King*, 801 F.2d 1324, 1327, 231 USPQ 136, 139 (Fed. Cir. 1986); *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 782, 227 USPQ 773, 778 (Fed. Cir. 1985).

The same inherency argument as applied above and in the rejection of the claims in each of *Park*, *Choi*, *Lee*, and *Hirase* applies here as well. Applicant has the burden of proof to demonstrate that the WF_6 --a halogen-containing substance-- does not prevent adhesion. It would appear that the instant application would be lacking enablement in light of such evidence since the applied art teaches treating the surface with WF_6 either prior to or during the deposition itself.

Conclusion

8. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

US 5,502,005 (**Mikagi, 109** in Fig. 4D) and US 5,622,888 (**Sekine et al. 73a and 73b** in Fig. 3(b)) each teach forming roughened tungsten surfaces. **Sekine** additionally teaches that the tungsten is an electrode in a capacitor.

US 4,552,783 (**Stoll et al.**) teaches that chlorine and bromine treatment of an insulator surface prevents nucleation of tungsten on the insulator surface, allowing selective deposition (Abstract).

US 4,913,929 (**Moslehi et al.**) teaches that surface morphology of tungsten nitride films is controlled by deposition conditions (col. 6, lines 53-68).

9. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

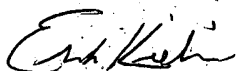
A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Art Unit: 2813

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 571-272-1693. The examiner can normally be reached on 9:00 - 19:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Erik Kielin
Primary Examiner
17 May 2004